Claims

[c1] 1.A method for automatically determining a structure cancelled image in a dual energy decomposition system, the method comprising:

obtaining a first high energy level image of internal anatomy formed of at least first and second types of structure;

obtaining a second low energy level image of the internal anatomy formed of at least first and second types of structure at an energy level lower than the first energy level image;

computing a characteristic mask using the low energy level image;

evaluating a first cancellation parameter against the characteristic mask;

computing a second cancellation parameter based on the first cancellation parameter; and

obtaining a structure cancelled image from the first and second energy level images according to a cancellation equation using one of the first and second cancellation parameter.

[c2] 2.The method of claim 1, further comprising:

generating a gradient mask from a ratio of the high to low energy images, at least one of the high and low energy images being adjusted based on the first or second cancellation parameter, wherein the gradient mask is used when automatically computing the first or second cancellation parameter.

[c3] 3. The method of claim 2, further comprising:

compressing the high and low energy level images used to generate the gradient mask.

[c4] 4.The method of claim 1, further comprising:

generating a gradient image based on the high and low energy images; and

comparing the gradient image with a gradient threshold to form a gradient mask, wherein the gradient mask is used when automatically computing the first or second cancellation parameter.

[c5] 5.The method of claim 1, wherein said step of computing a characteristic mask further comprises:

convolving a Sobel operator with an image based on the low energy level and the high energy level images to form a gradient image;

selecting a predetermined gradient threshold automatically from a set based upon a selected diagnostic application; and

creating the gradient mask by comparing the gradient image to the gradient threshold and assigning a first identifier to any image pixel greater than the gradient threshold and a second identifier to any image pixel less than the gradient threshold.

[c6] 6.The method of claim 1, wherein the cancellation equation represents a relationship between the high energy image and the low energy image adjusted according to the first or second cancellation parameter.

[c7] 7.The method of claim 1, wherein the first or second cancellation parameter is selected from a predetermined range in a look-up table, the range being determined by an effective kVp used to acquire the high level image and an effective kVp used to acquire the low level image.

[c8] 8.The method of claim 1, wherein the cancellation equation is:

$$I_s(x,y) = I_{HIGH}(x,y) / (I_{LOW}(x,y))^{w_s}$$

, and w_s is the first cancellation parameter, I_{HIGH} is the high energy level image, and I_{LOW} is the low energy level image.

[c9] 9.The method of claim 1, wherein the cancellation equation is:

$$I_b(x,y) = I_{HIGH}(x,y) / (I_{LOW}(x,y))^{w_b}$$

, and w_b is the second cancellation parameter, I_{HIGH} is the high energy level image, and I_{LOW} is the low energy level image.

[c10] 10.The method of claim 1, further comprising:

generating a localization image based on the low energy image; and

comparing the localization image with an intensity threshold to form a localization mask, wherein the localization mask is used when automatically

computing the first or second cancellation parameter.

[c11] 11.The method of claim 10, wherein the comparing step further comprises:
selecting the predetermined intensity threshold automatically from a set based upon said selected diagnostic application.

[c12] 12.The method of claim 1, wherein the step of computing the characteristic mask further comprises:
computing a gradient mask;
computing a localization mask; and
creating the characteristic mask by comparing pixels of the gradient mask to corresponding pixels of the localization mask and assigning a second identifier to the corresponding pixel of the characteristic mask if the corresponding pixels of the gradient mask and the localization mask are equal.

[c13] 13.The method of claim 1, wherein the computing the characteristic mask step further comprises:
assigning a first value to pixels representing only hard structure in the low energy level image; and
assigning a second value to pixels representing only soft structure in the low energy level image.

[c14] 14.The method of claim 1, wherein the evaluating step further comprises:
generating a series of gradient maps utilizing the cancellation equation and high and low energy level images by adjusting the first cancellation parameter to a value having a maximum likelihood of emphasizing the first type of structure.

[c15] 15.The method of claim 1, wherein the evaluating step further comprises:
computing multiple gradient maps using a range of cancellation parameters from a look up table; and
determining a lowest gradient value for each pixel location by comparing corresponding pixel locations of the multiple gradient maps to each other

and identifying an associated cancellation parameter for each of the identified lowest gradient values.

[c16] 16.The method of claim 15, further comprising:
creating a histogram comprised of cancellation parameters associated with the lowest gradient values derived from the characteristic mask; and
identifying a cancellation parameter occurring at the peak of the histogram as the value of the cancellation parameter having the maximum likelihood of canceling the first type of structure.

[c17] 17.The method of claim 15, further comprising:
identifying a value of the cancellation parameter having the maximum likelihood of emphasizing the first type of structure by calculating a mean of the cancellation parameters associated with the lowest gradient values derived from the characteristic mask.

[c18] 18.The method of claim 1, further comprising:
computing a hard structure cancelled image and a soft structure cancelled image using the cancellation equation, the first cancellation parameter and the second cancellation parameter.

[c19] 19.The method of claim 1, wherein the second cancellation parameter is linearly related to the first cancellation parameter.

[c20] 20.The method of claim 1, wherein said step of obtaining a structure cancelled image further comprises:
obtaining a first structure cancelled image from the first and second energy level images according to the cancellation equation using the first cancellation parameter; and
obtaining a second structure cancelled image according to the cancellation equation using the second cancellation parameter.

[c21] 21. A method for automatically determining a structure cancelled image in a dual energy decomposition system, the method comprising:
obtaining a first high energy level image of internal anatomy formed of at

least first and second types of structure;
obtaining a second low energy level image of the internal anatomy formed of at least first and second types of structure at an energy level lower than the first energy level image;
computing a gradient mask identifying a characteristic of interest from the internal structure based on a predefined cancellation parameter;
localizing the characteristic of interest from the gradient mask based on a constraint parameter to form a characteristic mask;
at selected pixel locations in the characteristic mask, varying the cancellation parameter over a range and obtaining for each selected pixel the cancellation parameter value yielding a desired characteristic mask value; and
determining a maximum likelihood estimate of a single value for the cancellation parameter.

[c22] 22.The method of claim 21, wherein the computing step includes computing the gradient mask for the first and second energy level images using an edge cancellation parameter and a gradient threshold.

[c23] 23.The method of claim 21, wherein the localizing step is based on an intensity threshold placed on the second energy level image.

[c24] 24.The method of claim 21, wherein the varying step includes incrementally stepping the cancellation parameter between upper and lower parameter limits and, at each discrete value for the cancellation parameter, calculating a gradient value.

[c25] 25.The method of claim 21, further comprising:
constructing a histogram of all pixel locations of interest from the characteristic mask.

[c26] 26.A method for automatically determining a structure cancelled image in a dual energy decomposition system, the method comprising:
obtaining a first high energy level image of internal anatomy formed of at least first and second types of structure;

obtaining a second low energy level image of the internal anatomy formed of at least first and second types of structure at an energy level lower than the first energy level image;

automatically computing a cancellation parameter having a maximum likelihood of canceling one of the first and second types of structure from a structure cancelled image; and

generate the structure cancelled image based on a cancellation equation using the automatically computed cancellation parameter, the structure cancelled image emphasizing the first types of structure and de-emphasizing the second type of structure.

[c27] 27.The method of claim 26, further comprising:

computing a characteristic mask storing a first identifier at each pixel location corresponding to the first type of structure.

[c28] 28.The method of claim 26, further comprising:

determining a characteristic mask storing a pattern of pixel values defining an image outline for the first type of structure.

[c29] 29.A method for automatically determining a structure cancelled image in a dual energy decomposition system, the method comprising:

utilizing a pre-computed look-up table of cancellation parameters for anatomies at various high and low energy pairs;

obtaining a first high energy level image of internal anatomy formed of at least first and second types of structure;

obtaining a second low energy level image of the internal anatomy formed of at least the first and the second types of structure at an energy level lower than the first energy level image; and

obtaining a structure cancelled image from the first and the second energy level images according to a cancellation equation using the appropriate cancellation parameter from said look-up table.